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Urban Wastewater for Agriculture: Farmers' Perspectives from Peri-urban Bengaluru

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Urban Wastewater for Agriculture: Farmers' Perspectives from Peri-urban Bengaluru

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Abstract: *Urbanisation, while offering marketing opportunities, inflicts considerable impacts on ecology, health, and livelihoods in the peri-urban farming areas. The city demands perishable products that need input intensive farming. In parallel, it also discharges domestic sewage and industrial effluents into peri-urban water bodies. The availability of wastewater for irrigation has been a saviour for peri-urban farmers, amidst the many constraints they face. Using nutrient-rich wastewater is also a smart strategy of combining fertiliser application with irrigation. This can balance nutrient flows between the consumption and production hubs. Concomitant and discernible implications of this process on the health of farmers, consumers, and the peri-urban environment, rarely receive needed attention. Even the discourse on sustainable cities seldom conveys the imperative of reducing consumptive use of water to curtail its forward and backward impacts.*

A participatory assessment using focus group discussions, multi-criteria mapping and a stakeholder workshop was conducted in Byramangala in order to understand the farmers' perspectives on their future as beneficiaries of wastewater (domestic sewage with industrial effluents) generated in the Vrishabhavathy watershed of Bengaluru city. Farmers were trying hard to adapt to the heavily polluted environment manifested in the restricted choice of crops, lower prices fetched by their produce, health impacts and resultant socio-cultural fallouts. The study also revealed high priority that farmers attach to health imparting attributes of agriculture. Their concerns on the two possible scenarios of wastewater supply were elicited. Farmers' preference for effectively treated wastewater was found to be overshadowed by its potential diversion for urban use. Despite concerns on water quality, they were keen to continue agriculture and would expect to be informed in advance about any impending diversions.

The political-economic 'eminent domain' of urbanism excludes the farmer constituency from strategizing freshwater extraction and the disposal of its wastewater. It needs to be confronted with concerted efforts to build institutional capacities for a decentralised wastewater governance, inclusive of downstream farmers, in place of pacifying measures like installing subsidised water purifiers for domestic use. The development and sustainability benefits of such efforts will include reliable farm livelihoods built on regional circular economies along with safe and healthy food and the environment in the urban - peri-urban continuum.

Keywords: *wastewater irrigation, multi-criteria mapping, peri-urban agriculture, Byramangala, Bengaluru*

Urban Wastewater for Agriculture: Farmers' Perspectives from Peri-urban Bengaluru[1]

Seema Purushothaman, Sheetal Patil, Raghvendra S. Vanjari and Shwetha A. R.

1. Urban expansion – thirsty, wasteful and polluting

Expanding urbanisation has become the face of development, even in the global south. It is touted not as an essential fallout of development, but as development itself, promising livelihoods and consumerist lifestyle. Common assumptions about urbanisation include the possibility of taking people away from the drudgery of rural life and livelihoods and the potential to generate good demand for rural produces. While these well-known assumptions have been questioned in Purushothaman and Patil (2019), what we question here is another implicit assumption. It is about the notion that what the city discards is useful for the peripheries and hence urban planning and governance can be indifferent about the quantity and quality of wastewater released.

Globally, the population in urban areas surpassed the rural population in the year 2007, making cities densely populated than ever before. UN's estimates show that more than two-thirds of world population and more than half of all Indians will be living in urban areas by 2050 (United Nations, 2019). Such concentrated human settlements demand large volumes of fresh water, while discharging equal, if not larger, volumes of polluted water into the downstream peripheries of a city. As the growth of towns and cities continue to be socio-ecologically insensitive, ensuring the adequacy of quality water becomes a universal challenge in the 21st Century. The widening gap between the demand and supply of quality water, alongside a large quantity of sewage flowing out of urban settlements, remains an inevitable outcome of development in most parts of the world.

1 **Acknowledgements:** We acknowledge the financial support received from the Department of Biotechnology, Government of India for the Project *'Ecosystem services, agricultural diversification and small farmers' livelihoods in rural-urban interface of Bengaluru'* as part of the Indo-German collaborative research project FOR-2432. We extend our sincere gratitude towards farmers and other stakeholders for actively partaking in multiple discussions. We appreciate input from Hannes König [Leibniz-Centre for Agricultural Landscape Research (ZALF)] towards the initial ideation on participatory methods.

Cities source fresh water from large freshwater bodies – rivers and lakes – far and near. At the same time, almost the entire water used by the city, including the untreated wastewater, ends up in water bodies near farmlands lying immediately downstream to the city. Industries usually located inside or in the fringes of big cities also let out their wastewater directly into the water bodies around. Thus, farming communities in the urban peripheries face the double-edged sword of plentiful and free supply of filthy water, when many inland agrarian communities vie for some access to irrigation.

Irrigated agriculture has direct forward as well as backward linkages with urbanisation. Urban demands drive new agronomic practices that otherwise primarily serve the food needs of people in and around the agroecosystem. Multifunctional farms turn into enterprises mostly or entirely catering to a distant consumer population inhabiting urban landscapes. Marketing - that confined to the surplus left after local consumption - has been turned around to be the sole objective of agriculture. Making an exclusively commercial enterprise out of small-scale family operated agriculture, in response to urbanization drives heavy exploitation of available hydrological and biological assets. Thus, peri-urban farmers generously using wastewater in producing high-value perishables to meet newer demands of the city become part of the hydraulic farming societies known for their rent seeking behavior. Farmer rent seekers conventionally were operating around canal irrigation projects or capital intensive private borewells (characterized for the wild west in Worster, 1985 and in the context of large dams in India by Singh, 1997). The turf grass growers and poly-house producers of exotic flowers and high-value vegetables, found scattered around any big city in India are part of this new hydraulic farming community. They stand in contrast to the agrarian communities engaged mostly (may not be exclusively) in rain-fed farming while meeting their basic food needs from farming.

Every year, cities of the world generate 380 million cubic meters of wastewater; equivalent in volume to the entire flow in the mighty river Ganga (Qadir and Smakhtin, 2020). Asia's share is the largest in this, with 159 million cubic meters (42%) of total wastewater generation in the world. In per capita wastewater generation, North America leads the trend with 231 cubic meters. As per a decade old estimate, about 20 million hectares was being irrigated by polluted water released from the cities across 50 countries, and about 10% of the world's population consumed crops produced using wastewater (WHO 2006; Smit and Nasr 1992). More recent estimates for India (National Status of Wastewater Generation and Reuse (2016)) say that every day nearly 61,948 million litres of wastewater is being generated in the country. Out of this, about 60% comes from Class I and II towns. About 37% of this polluted water is estimated to be treated (CPCB, 2016). Thus, nearly 73,000 hectares of farm land in the country has been irrigated with mostly untreated wastewater (Table 2 in Thebo et al., 2017).

Just like the double-edged sword mentioned earlier faced by the peri-urban farmers using plentiful supply of sewage for irrigation, food and agricultural sectors too face mutually contradicting outcomes with regards to wastewater use. Agricultural sector being the largest consumer of fresh water, utilising wastewater for irrigation can potentially reduce the pressure on freshwater sources and the water footprint of farming. But this dual benefit comes with a significant cost in terms of human and livestock health, both in the production and consumption landscapes. Thus, despite its potential to benefit both producers and consumers, adverse impacts of city's fluid waste galore. The regional (urban and peri-urban) planning and governance continue to be socio-ecologically insensitive to these impacts in most parts of the Global South. A rigorous discourse and adequate action on reducing extraction, use and pollution of a scarce resource like fresh water seems to be conspicuously missing (Saiu, 2017; Satterthwaite, 2016), even in the initiatives like Sustainable Cities (UNDP, 2015) or the New Urban Agenda (UN, 2017).

2. Farming with wastewater

The use of domestic sewage for farming has been a practice in vogue since the earliest of civilisations. Diversion of domestic wastewater from cities like Athens and Rome to their peripheries for fertilising crops and orchards were well known in Greek and Roman civilisations. The 19th Century saw many growing cities irrigating peri-urban farms with wastewater. However, the transport of sewage through open drains and its discharge into open fields soon triggered epidemics of water-borne diseases. In the mid-19th Century, underground sewage systems emerged in response to the unhygienic conditions arising from rapid urbanisation and industrialisation in major European cities (Winiwarter et al., 2016). Still, untreated wastewater continued to be used for farming.

By the end of the Second World War, universalisation of the North American norms of sanitation and hygiene together with the advent of synthetic fertilisers, prevented possible emergence of efficient, sustainable and equitable ways of using urban wastewater. Changes were needed in the planning process, technology and in the social taboo attached to communities that used or handled the wasted and leftover materials from urban consumption. Untouchability towards the communities engaged in manual scavenging (disposal of night soil earlier and cleaning drains and sewage systems now) continued as a social malady, though the use of night soil in agriculture had ceased much earlier in most parts of the country.

It was only in the late 20th Century that various protocols of wastewater use in farming were developed by the World Health Organisation, Food and Agricultural Organisation and the Environmental Protection Agency. Collating more than a dozen good practices from countries around the globe, Hettiarachchi and Ardakanian (2016) highlighted the benefits of efficiently reusing urban wastewater in agriculture using such methods. Financial benefits of using wastewater included the avoided overhead and operational costs involved in other modes of irrigation as well as in buying manures and fertilisers. These benefits are echoed in most studies on the use of sewage for irrigation. For instance, Bhamoriya (2004) found wastewater irrigation turning out to be an economic catalyst among the marginalized communities in Vadodara, Gujarat. Similarly, in the surroundings of the twin cities of Hubli-Dharwad, Bradford et al. (2003) found that sewage irrigation enabled an additional crop either before or after the rainy season. They estimated nearly

20-25% yield advantage in agro-forestry systems using sewage, compared to crops irrigated with groundwater. Case studies in five Indian cities – Ahmedabad, New Delhi, Kanpur, Hyderabad and Kolkata - revealed considerable financial benefits to farming due to the use of urban non-industrial effluents, instead of fresh water (Amarsinghe et al., 2013).

With effective monitoring, not only crop cultivation, but a range of allied activities like pisciculture can be undertaken with treated sewage.[2] Apart from provisioning food, the use of treated wastewater has been found to enhance other ecosystem services from multi-functional peri-urban agro-ecologies (see Attwater and Derry (2017) for a case study near Sydney, Australia).

Challenges

Literature on the potential use of sewage in irrigation emerged during the early 1990s, though the associated risks gained attention more recently. Risks include changes in the chemical and microbiological properties of soil (Jaramillo and Restrepo, 2017) as well as accumulation of heavy metals in fresh vegetables (Ghosh et al., 2012). Thus, the issues of food safety and contamination usually attributed to agricultural chemicals got another culprit in the cities. What is noteworthy is the difference among countries in tackling the negative side of using city's wastewater. A comparison of 44 countries (Khalid et al., 2018) shows significant variation between developed and developing countries in handling environmental and human health issues arising from the use of city sewage. While the former efficiently managed collection, recycling and reuse of wastewater; social, economic, corporate and legislative factors interfered with wastewater management in the latter. There are studies that show how the wastewater problem can be tackled in the Global South struggling with such a dismal track record.

So, the challenge is to maximise benefits while curtailing the negative effects of using city sewage for agriculture. Conventional Benefit-Cost Analysis (BCA) may not work here because of the public goods nature of services involved. Hussain et al (2001) tried to make such an assessment of the socioeconomic, health and environmental aspects of urban wastewater use in peri-urban agriculture in Sri Lanka, Pakistan and India. The authors acknowledge the limitations of BCA, citing lack of evidence of a direct relationship between diseases and sewage irrigation, as well as difficulties in monetising morbidity and mortality. Despite such difficulties, according to the authors, BCA can play a role in the process of decision-making about the use of sewage.

As mentioned before, the phenomenon of rent seeking[3] by the peri-urban hydraulic communities of farmer entrepreneurs through the careless use of city's wastewater co-exists with widespread distress in agrarian rural India. Complexity and conflicts prevailing in the rural-urban interface are reinforced by expanding urban areas that demand both quality water and high-value food produce

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2 East Kolkata wetlands spread over 125 sq. km. host numerous fishponds set up by nearly 50,000 fisherfolks. Fed by wastewater from the city, these fishponds help them rear about 10,000 tonnes of fish every year (Doshi, 2017).

3 Akin to the concept of Ricardian economic rent, ecological rent seekers try to maximize profits by appropriating public goods and ecosystem services than creating new wealth.

while expelling large volume of wastewater (and solid waste too, but not a subject for this paper). Given the complexities in farming with wastewater, situated amidst the desperate plight of rainfed agrarian India, this empirical study attempts to unpack perceptions of peri-urban farmers on using Bengaluru's wastewater.

3. Bengaluru city and its water footprint

Currently, the city pumps about 1,350 million litres of fresh water per day from Cauvery river, almost 100 km away from the city for its consumption. The remaining demand for domestic as well as industrial use is met from aquifers below the ground. The city officially expels 1,400 million litres of wastewater every day.[4]

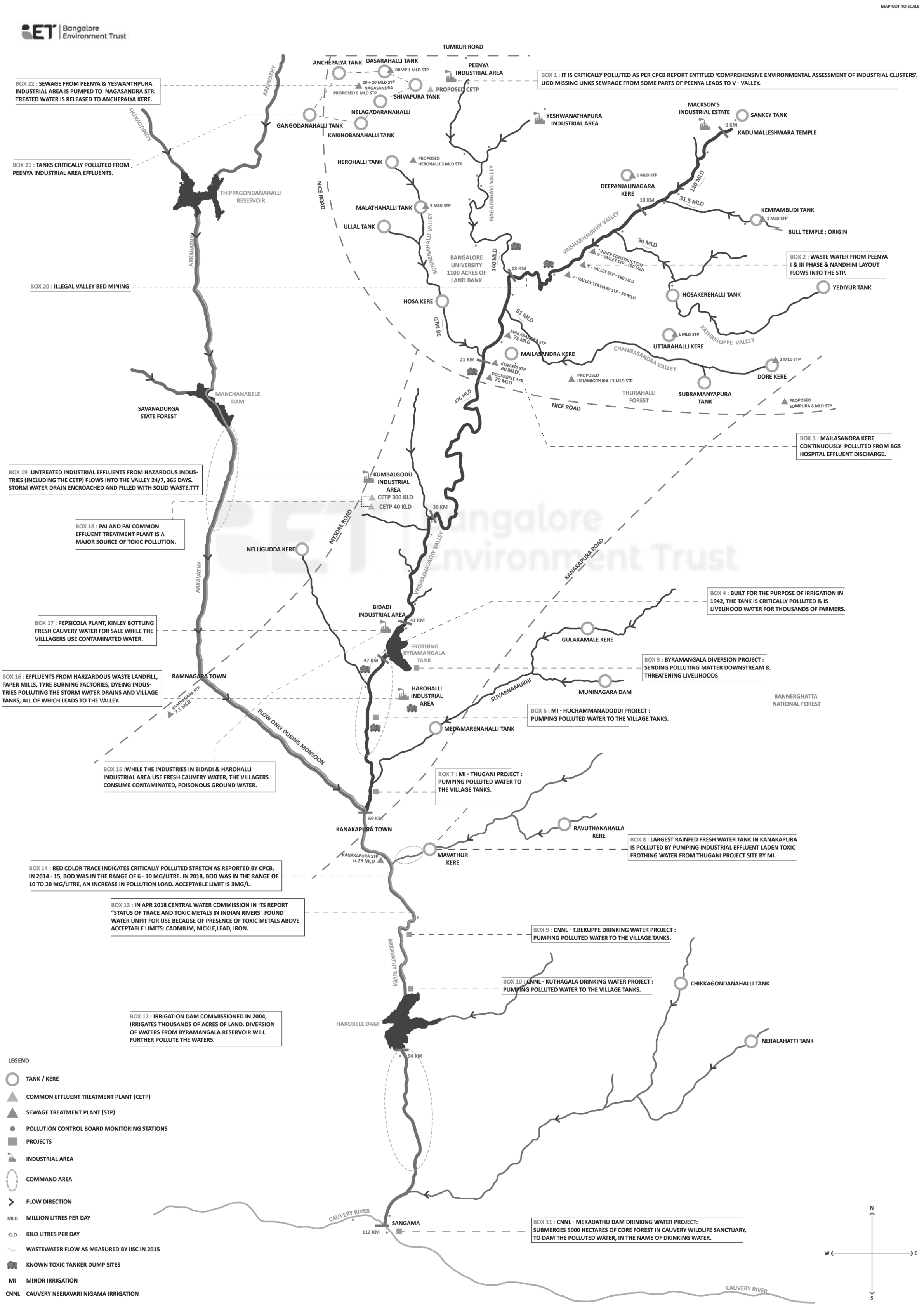
Despite the rapid expansion of population and urban infrastructure, many water bodies have disappeared over the last few decades, Bengaluru's metropolitan area still has a considerable number of lakes and even (what used to be) a small river - Vrishabhavathy. Storm water channels connect the city's lakes. The river originates in the north-western part of the city and flows towards its south-western periphery (Fig. 1). Vrishabhavathy catchment is part of the Arkavathy sub-basin, and the two rivers jointly meet river Cauvery, about 60 km further down from the city's boundary.

One-third of Bengaluru city falls in the Vrishabhavathy catchment (170 sq. km.). The river used to cater to the water requirement of West Bengaluru and the agricultural needs of adjacent villages till the 1970s when public sector industrialisation slowly started changing the face of the city. These changes became rapid between 1991 and 2011, when population density in the river's catchment area within the city, increased from 76 to 177 persons per sq. km. Planning and governance mechanisms for urban water and wastewater could not keep pace with this rapid infilling of the city. Vrishabhavathy that was a seasonal freshwater stream was converted into a perennial sewer, by this unplanned and insensitive urbanisation. Vrishabhavathy valley received 480 million litres of the city's wastewater per day in 2017 and is expected to reach 596 million litres in 2021 (Ramachandra et al., 2017).

In 1943, a dam was built across Vrishabhavathy at Byramanagla, about 40 km downstream to the south of Bengaluru city. Byramangala reservoir is now spread over 412 hectares and receives about 470 million litres of wastewater per day through Vrishabhavathy. Outflow from the reservoir flows through the left channel of 26km and a right channel of about 8 km in length. Between the two channels, about 1,800 hectares (66% of the cultivated area in this region) of agricultural land is irrigated in Byramangala, which is the focus of this study.

4 Estimates by Bengaluru Water Supply and Sewerage Board. This is the amount of sewage that reaches treatment plants (STP). Reliable estimates of urban wastewater that bypass STP, is unavailable. (https://www.bwssb.gov.in/com_content?page=3&info_for=3)

Figure 1. Vrishabhavathy and other smaller streams joining from different locations within Bengaluru city limits

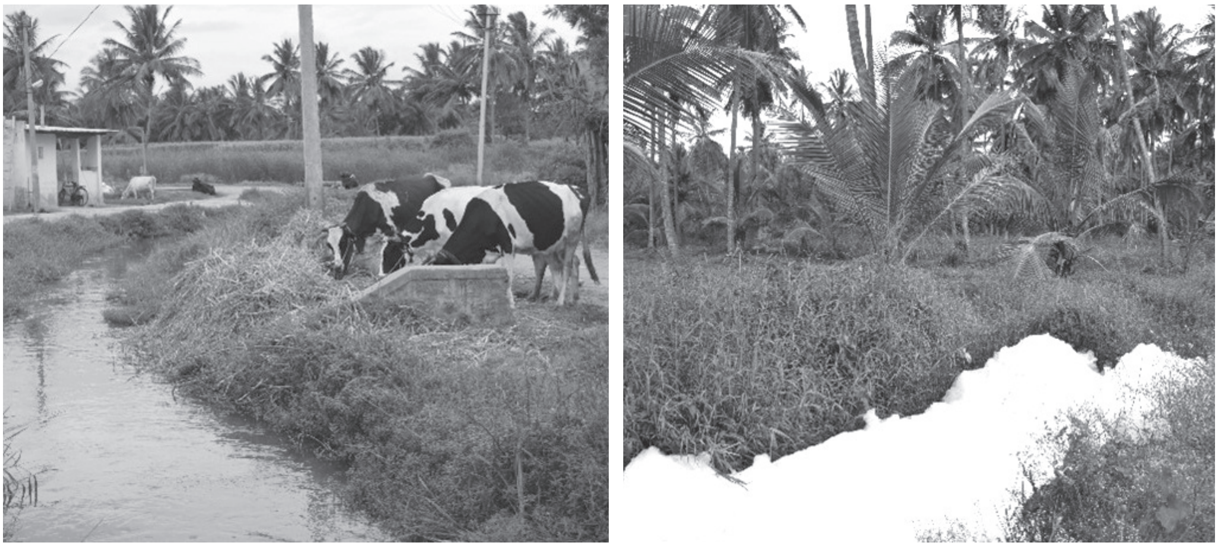


Source: Bangalore Environment Trust, Vrishabhavathy-Arkavathy Rivers in a Nutshell – Map (https://bngenvtrust.org/wp-content/uploads/2020/05/Arkavathy-River-Basin-Map_BET.pdf)

Demographic analysis from the 1990s points to the fact that, while the people in Byramangala continued to engage in agriculture, farmers in other parts of peri-urban Bengaluru shifted in large numbers to non-farm occupations (Thomas et al., 2017). This indicates that unlike some other peripheral farming areas around Bengaluru, agriculture continues to be an important livelihood in Byramangala. Currently, popular crops grown here are fodder grass, baby corn, mulberry and coconut. Banana and finger millet are cultivated wherever land is suitable, and wastewater doesn't reach.

During our exploratory visits in the summer of 2017, we could not help contrasting the lush green fields lined with coconut trees spread around the Byramangala lake with relatively dry agricultural landscapes around other parts of Bengaluru. Here, throughout the year, channels carry nearly constant volume of wastewater. Farmers said that as long as Bengalureans have enough water for their use, they will continue to have assured irrigation. Thus, the city's wastewater helps them cultivate commercial crops throughout the year, resulting in notable financial gains. Yet, it was difficult to ignore the other side of this boon. Large foamy bubbles around five feet tall and the stench hanging in the air, debilitates the quality of life in an otherwise scenic spot (see Fig. 2 below).

Figure 2. Fodder grown using wastewater and foamy water in the irrigation channel



Water quality tests by Suma and Srinivas (2017) show high hardness, way beyond standard permissible limits. The continuous use of heavily polluted water for irrigation makes the soil saline and leads to '*sewage sickness*'. For the last couple of decades, water pollution has been increasing further. Water samples drawn from surface and ground sources and samples of fodder, milk and baby corn contained heavy metals exceeding the prescribed limits (Thomas et al., 2017, Jamwal et al., 2014, Suma and Srinivas, 2017). The impacts of heavy metal contamination on human and livestock health are now well established (see Jaishankar et al., 2014; Singh et al., 2011).

Remedial measures

The above depicted picture of Byramangala adds another layer of concern - the failure of monitoring, regulation and governance of city's water use, briefly mentioned before. Exchanges or flows (materials, resources including human) between the city and agricultural landscapes in its periphery include that of land, water, labour, farm produce, investment and wastewater. The current imbalance and skewness observed in these flows are in favour of the city. This urban bias is thanks to the unrecognized role and stakes of peri-urban production landscapes and communities[5] in urban governance and planning. Imbalance in the flows between the city and the peripheries widens the social, economic and ecological rift between producers and consumers. The untapped potential in synergizing urban planning with agro-ecology has been highlighted in Patil et al. (2018). The emerging concern about a conspicuous absence of farmers' perspectives in urban land and water planning, cannot underplay the need to strengthen related institutions like pollution control board (Jamwal and Lele, 2017).

Government of Karnataka introduced a Policy for Urban Wastewater Reuse [Urban Development Department (2017)] and an Action plan for Bengaluru (Karnataka State Pollution Control Board, 2019). Various departments and civic bodies such as Urban Development Department, Bengaluru Water Supply and Sewerage Board, Karnataka State Pollution Control Board, Karnataka Urban Water Supply and Drainage Board, Minor Irrigation Department and the Directorate of Municipal Administration together prepared the policy and plan. The policy aims to reuse 20% of wastewater by 2020 for agricultural, industrial and urban non-potable purposes. However, farmers were not part of consultations for drafting the policy.

While formal governance institutions functioning at the interface of the city and farms leave a lot to be desired, change is being nudged from the other end. Consumers in the city are slowly waking up to the role of food safety in human health and well-being. As a result, Byramangala farmers selling their produce on the roadside markets faced queries about the place and method of production, especially that of leafy vegetables. Thus, even though high nutrient content of wastewater aids better crop production, there were financial consequences in addition to the impacts on the health and environment of producers and consumers. Nevertheless, they seemed to be worried about another related matter - the quality, quantity and accessibility of wastewater itself.

Given the above complexities entailed in farming with sewage and the anxieties prevailing among farmers, it was felt important to gather and analyse the concerns, claims and suggestions through a systematic participatory study. Mentioned in the below sections are the specific methods used in the study alongside their purpose.

5 See Purushothaman and Patil (2019) for a detailed exposition of how this imbalance varies across a typology of peri-urban areas

4. Integrating farmers' perspectives

Recent studies on wastewater irrigation focus on its' biological and chemical parameters (e.g. Jamwal et al., 2014, Suma and Srinivasa, 2017, Ravikumar et al., 2013). Farmers' perceptions appear to be inadequate, if not totally missing, in these discussions. Thomas et al. (2017) did raise questions of rights over water and environmental justice for both people as well as aquatic life in areas downstream of Vrishabhavathy. Limiting largely to coping strategies, such interdisciplinary studies also advocate participatory monitoring and management of wastewater for irrigation. What is missing is a systematic adoption of participatory methods for their analysis and evaluation of the complexities involved. This case study with its larger goal of environmental and distributional justice surrounding the urbanisation process, tries to address the insufficiency of farmers' voices in such literature, by methodically involving farmers in assessing the impact of both quality and quantity of urban wastewater for irrigation. They were also engaged in informed imagination of future scenarios that will unfold in a span of about 15 years from now.

The specific objectives of this case study are to:

1. Identify and understand the nature of trade-offs in farmlands irrigated with urban wastewater
2. Identify and assess future pathways for peri-urban smallholders who use wastewater for irrigation

The research process involved exploratory visits, transect walks, participatory resource mapping, Focus Group Discussions (FGDs), Multi-criteria Mapping (MCM) and stakeholders' meet, in that sequence. While exploratory visits helped in contextualizing the myriad problems of expanding urbanisation and to select the most representative villages for the study; transect walks and participatory resource mapping were used to closely understand the village setting and available resources. FGDs helped in developing a framework of indicators required for impact assessment and for collectively unravelling possible scenarios.

Four villages were selected from the 32 villages that were explored within the Byramangala command, on the basis of the extent of irrigation by wastewater, social categories present in the village and readiness to participate in discussions. FGDs and participatory resource mapping were to be conducted in these four selected villages.

Qualitative and quantitative impacts on selected aspects[6] of smallholder farming in the identified scenarios were mapped using MCM. In this process of measuring impacts in accordance with how farmers of the study villages perceived and articulated their life around agriculture, the study distanced itself from conventional indicators like the productivity of specific crop or an animal. MCM applied elsewhere, for instance by Harriss-White et al. (2019) in comparing different methods of rice cultivation, seems to be slightly different from what this study uses it for. Participatory methods in this study were adopted early on, starting with identification of the study villages, of the trade-offs involved and also of scenarios before applying it in assessing the plausible impacts.

6 The process of selecting the aspects to assess is mentioned in Sec. 4.2

4.1. Walk-through and mapping of resources

Interactive transect walks7 were held in the four selected villages, in the company of the respondent farmers identified during the exploratory visits. These interactive walks were supposed to reveal how generally everyday life goes on in these villages. They helped the authors to locate settlements, farmlands, water bodies, rural common lands (grazing land, forest, places of worship and cemeteries), industries, dairy and other collectives, as well as markets and other structures - all vis-a-vis the channels from the Byramangala reservoir. This exercise was useful in two other ways too - in building rapport with the key respondents and in the preparation for resource mapping. On a pre-planned day after the transect walk, authors sit together for 3-4 hours with the key respondents and a few other villagers who join during the walks, to sketch out a resource map of the selected villages (see Annexure 1 for the resource map of a study village). Exploratory visits and interactive walks followed by preparation of resource maps helped us to be on the same page as the villagers, regarding the current social and environmental context in which they live. They also helped in designing and administering questions for the following step i.e. FGD.

4.2. Recalling transitions - nature, people and farming

The major purpose of FGD as mentioned earlier was to help arrive at an indicator framework for impact assessment. FGDs consisted of conversations around changes in ecology and farming systems. Focus groups were formed keeping in mind the social categories present in the village and proximity to the reservoir, in order to capture variations in trade-offs and impacts. Seven FGDs with 70 farmers; including men, women (36) and members from disadvantaged communities (10) were conducted. A list of guiding questions[8] helped in keeping the group discussions focused on agro-ecology (soil, water, biodiversity, landholding and livestock), the socio-cultural context (standard of living, collective spirit, family welfare, gender roles) and infrastructure (industries, irrigation, water treatment).

Conversations hovered around the trade-offs entailed in availing the easy access to irrigation available in the area and about mechanisms to cope with the changing nature of irrigation water, both in terms of quantity and quality. Deliberations came up with prospective irrigation scenarios, based on the group's understanding of the prevailing political-economic context.

Key messages from the FGDs:

a) For most households, agriculture and allied activities constituted the most important, if not the only, occupation. Only a handful of households seemed to have moved completely away towards non-farm livelihood options. Most farmers were small and marginal landholders and some of them were leasing land to supplement their own.[9]

7 Lateral and transverse transects of the village landscape covered the main streets, hamlets and fields.
8 See Annexure 2 for the questions that formed the basis of FGD.
9 Households not owning any land were rare in these villages, irrespective of social category.

b) There was consensus on how water quality and quantity changed in the last 2-3 decades. While the quality of water deteriorated, water quantity increased manifold. Both quality and quantity varied only slightly between months, depending upon rainfall and discharge of industrial effluents. Farmers could infer and articulate changes in both the biophysical (e.g. soil character) and socio-cultural (e.g. specific customs and festivals) aspects of farming in response to the above changes in irrigation water.

c) Transitions in farming practices were largely associated with deterioration in the quality of irrigation water. The changed character of soil restricted their choice of crops and brought down the product quality. A cropping pattern that was a combination of finger millet, paddy or sugarcane along with a few other crops in minor acreage, shifted towards a system dominated by baby corn, fodder and/or mulberry (also reported in Thomas et al., 2017). Coconut trees remained in the landscape despite the increased flow of poor-quality water in the irrigation channels. Few were applying soil amendments and use of pesticides confined to dire situations of pest attacks. However, proliferation of weeds seemed to be critical and farmers usually resorted to weedicides. They pointed out species of weeds that they had never seen before and commented that the seeds of these weeds were brought by the wastewater.

   Fodder cultivation could thrive in wastewater laden soils and most farm households were keeping milch cows. As a result, villages hosted vibrant dairy cooperatives along with livestock feed distribution agencies as well as veterinary services. Dairy farming flourished well for more than a decade. Off-late, poor quality of milk is pulling the price down such that often expenses outweigh earnings, despite some support from the state government. Thus, wastewater flow - a factor that enabled widespread adoption of small-scale dairying and fodder cultivation, is becoming its own enemy – triggering glut in the market and poor-quality of the produce-fetching very low prices.

   Much like the case of milk or leafy vegetables, they faced problems while selling the silkworm cocoons. Reeling yarn from the cocoons of silkworms fed on mulberry leaves grown using wastewater is said to be cumbersome. Hence silk traders offer lower price to cocoons produced by the farmers in Byramangala. In order to circumvent the label of *'Byramangala cocoons'*, farmers try to pool their cocoon harvest with that of their relatives from other villages.

   FGDs also pointed to the decline in the diversity of edible crop species over the last couple of decades. Farmers simply could not earn much from food produce high in water content like vegetables, that often carried a persisting foul odour. Despite all these disadvantages and unlivable surroundings, their living standards in terms of housing and vehicle ownership improved till recently owing to the new combination of three commercial produces - baby corn, milk and mulberry.

Grey, frothy water along with spreading stench and mosquito menace announced the irony in improving income status at the cost of quality of life. The mosquito menace was so acute that many farmers used pesticides and installed industrial fans and nets to protect their cows. Fogging was not an option as it damages the silkworms feeding on mulberry. People and livestock suffered from skin ailments. Alterations in cropping pattern to cope with the large volume of poor-quality water, triggered changes in diet patterns, cultural practices, social networks and social norms.

d) Mulling over the lack of non-farm skills with them, farmers were thankful for the yearlong water (wastewater) availability, which in fact has been increasing over the past 15 years or so. If irrigation was not a possibility, according to farmer respondents, there would have been large scale land alienation and disputes among landholding families. Farmer: *"Irrigation is our lifeline. Without water from Byramangala we wouldn't be able to grow even a blade of grass".* Leveraging on existing skills and reliable urban demand, women made use of the water from Byramangala for dairying and cocoon rearing.

e) Illustrating the white layer formation on the surface of groundwater stored for a few hours, they pointed to a possible ingestion of industrial chemicals along with salts from the water they use. Farmer: *"though it is against our custom, we avoid offering drinking water to guests like you. We are worried that people who are not used to such water may fall seriously sick".* The authors approached the local health centers for information on the health consequences of water available in Byramangala for domestic use. But there wasn't any discernible data or alarm about this. They could only relate cases of skin ailments with water quality.

Since both surface and groundwater were contaminated, people bought drinking water from purifiers fixed by the government and some private companies at a subsidized price of ₹ 5 for 20 litres. Bengaluru - the city that takes away fresh water from, and dumps waste water into the rural landscapes, try to mitigate the damage by installing water purifying machines for drinking water supply in these villages - an instance of using welfare measures as pacifiers against dispossession meted out by the coupled and expanding processes of economic growth and urbanisation. Apart from the ethical irony involved, regular maintenance of these purifiers is often ignored, much like the unmonitored and hence uncontrolled pollution of Vrishabhavathy that necessitated the setting up of such water purifiers here.

Villagers sounded embarrassed to mention the difficulty in finding brides for the menfolk of the village. If they manage to find a bride of their choice, it was very difficult to persuade her to come and stay with her in-laws in Byramangala, as is the patriarchal custom. Painfully acknowledging that the tradition of worshiping the river has ceased farmers pointed out how they have been coping with and adapting to the changes in Vrishabhavathy waters. Nevertheless, they appeared anxious about their future in the villages on the banks of Vrishabhavathy.

f) Contrary to what the authors expected, farmers' anxieties were not so much about the continuation of untoward impacts of heavily polluted water and the environment. It was more about the upstream efforts to treat wastewater and to clean the reservoir. The reason behind this counter-intuitive concern was the fact that any improvement in the treatment of wastewater meant a possible diversion for the city itself.

The origin of this concern was in the diversion of raw and treated wastewater happening since 2019.[10] Villagers in Byramangala did not know about it till it happened. Sudden reduction in the flow of water in the irrigation channels made their worst fears come true. The city wanted to dump its wastewater in this peri-urban landscape as long as the wastewater treatment was ineffective but staked claim over treated wastewater when it became reasonably clean. It was apparent that as the water becomes cleaner, less of it will flow in the channels of Byramangala. This led to the emergence of two potential scenarios for the next 15-20 years (Table 1), from FGDs.

Table 1. Future irrigation scenarios in Byramangala

Status quo	Quality and quantity of irrigation water remains the same.
Cleaner but limited water	Better quality irrigation water from efficient wastewater treatment, but the quantity diminishes due to diversion to the city.

To summarise, FGDs gave us a mixed bag of concerns and privileges and two possible irrigation scenarios in Byramangala. We also identified the attributes or aspects of farming that people often referred to in their narrations. We identified 18 such agricultural attributes ('aspects' from now on) that were mentioned by the farmers during FGDs. These aspects were later used to explore farmers' perspectives on the future of farming. Following FGDs, we embarked on prioritizing their multiple concerns and sentiments through a ranking of these aspects and then started assessing the expected impacts on selected aspects, through a scoring exercise.

4.2.1. Priority aspects of farming from two outlooks

During the first pilot exercise to assess farmers' perception of the impacts of wastewater irrigation, the aspects gathered from FGDs were reduced to 10 (from 18), omitting those with overlaps. These 10 aspects of farming (Table 2) were supposed to help us to critically evaluate the future of farming in Byramangala villages. Financial outcomes from individual crops or livestock were not among these concerns, as they were heavily dependent on market dynamics and not just on the inherent attributes of agriculture.

10 Diversion of city's wastewater has been happening from other drainage valleys towards the North-East of Bengaluru since 2017. For diversion from Byramangala, cost estimates were submitted by Cauvery Niravari Nigam Niyamitha and sanctioned by the state government in 2018. Civil works were happening in the lake to divert water during our field work in the summer of 2019. See Gowda (2019) for a critique of this project.

Table 2. Key aspects of agriculture according to farmers of Byramangala

Aspect	Description	Key used for explaining indicators
Family health	Health status of family members	Number of times family members fall sick and the number of workdays lost due to ill health
Livestock health	Health status of domestic animals	Number of times animals were sick and treatment expenditure
Soil fertility	Health of soil	Adequacy of moisture, presence of earthworms and other beneficial soil organisms; productivity of crops grown
Living environment	Hygiene and cleanliness in the surroundings	Segregation and recycling of solid waste; absence of open garbage dumps near roads or water bodies, mosquito menace; unpleasant smell
Edible biodiversity	Diversity of food crops grown	Variety of food crops grown for the family- vegetables, fruits, tubers, herbs, cereals, etc.
Local Biodiversity	Diversity of uncultivated flora and fauna in the village	Variety of trees, birds, insects, animals, reptiles, fish
Farming skills and know-how	Agricultural know-how and skills in the farm family	Knowledge on crops suitable for soil types, on seasonal timing and methods of operations, useful rotations and combinations, soil enrichment, residue management
Occupational satisfaction	Contentment in engaging in agricultural activities	Identity as an agriculturist; direct link with nature; joy of farming; sharing and tasting the fruits of labour; health benefits of manual labour; aesthetics
Land utilisation	Utilising all land that is available with the family for cultivation and allied activities	Absence of long fallow periods - using land to the fullest extent for agriculture in regenerative mode
Collective initiatives	Participation in common activities	Initiate or partake in collective actions towards agricultural improvements, including appropriate know-how and skills

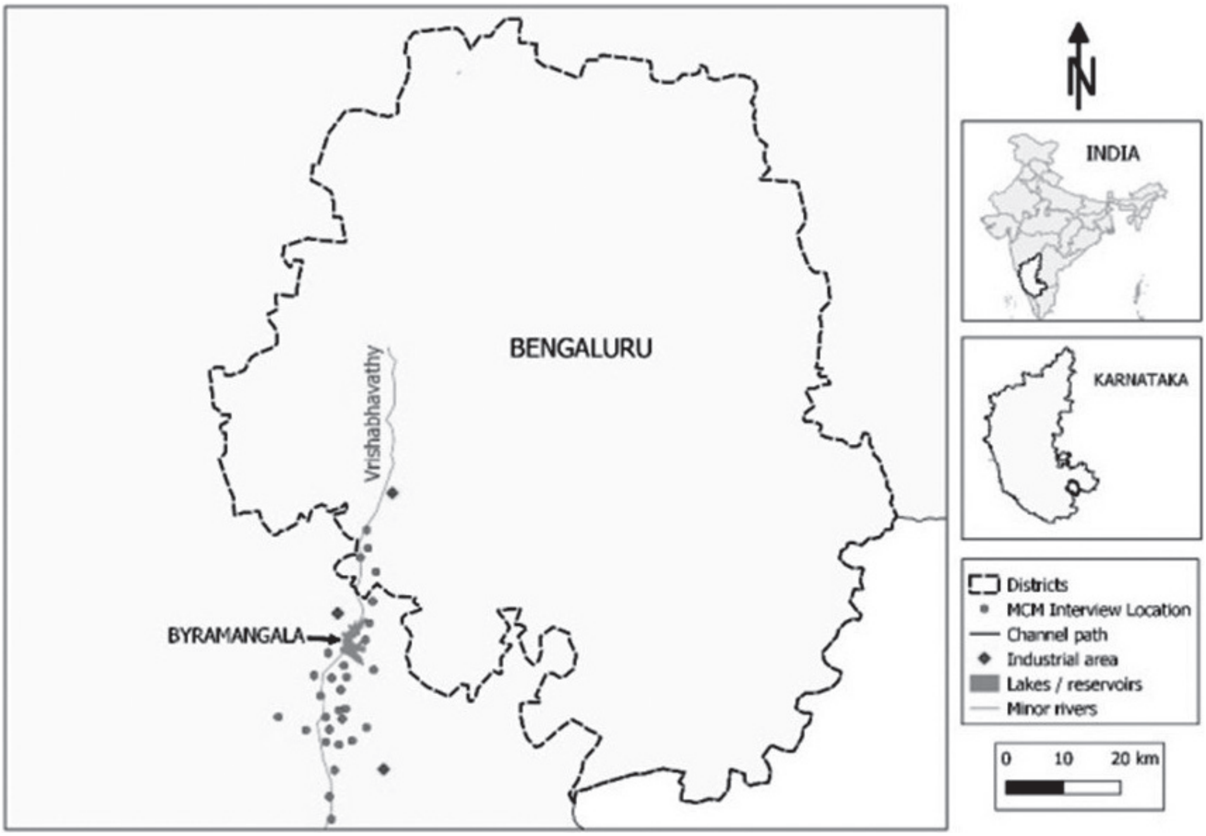
The above aspects would vary in their status between the two scenarios identified in FGDs. But they were again shown to vary depending on other exogenous factors since expectations about the larger context (e.g. governance, technology) around each aspect were diverse. Hence the selected 10 aspects were evaluated for impacts under the two scenarios (Tables 1 and 2) through a scoring exercise, from two kinds of opposite expectations - positive and negative outlooks (Table 3). Thus, in MCM, each farmer respondent assigned a pair of impact scores for each aspect under each of the two scenarios.

Table 3. Outlook towards the future of Byramangala's agriculture

Aspect	Optimistic outlook	Pessimistic outlook
Family health	New medical approaches for treating water-borne diseases, public health care, spreading awareness and precautions, well trained medical staff in village hospitals	Unaffordability and inaccessibility of healthcare system, discrimination/ corruption and lack of awareness
Livestock health	Specialised veterinary services and breeds tolerant to wastewater; new vaccines and hormone supplements	(Same as above)
Soil fertility	Effective soil science to treat nutrient imbalance, soil fatigue and salinity; local soil labs and staff to monitor; efficient water management	Farmers' indifference (despite awareness); inefficiency and corruption among officials involved in schemes for soil conservation
Living environment	Efforts by civic bodies to keep the surroundings clean; planning and implementation of effective waste treatment; active leadership by local Panchayat in sanitation	Citizens' indifference towards public hygiene; industries flouting pollution norms; rapid increase in wastewater discharge and local efforts effective only in the short run
Edible biodiversity	Vegetable seeds for local conditions made available; cost effective wastewater treatment to grow local food crops; availability of bio-fertilisers and bio pesticides	Plots shrinking in size; culinary needs met from the market; new cash requirements pushing high-value crops
Local biodiversity	Recognising the benefits, farmers protect natural biodiversity; plant more local trees, attract pollinators	Urban expansion and infrastructure projects, as well as synthetic inputs take a toll on biodiversity
Farming skills and know-how	Efficient extension agencies, NGOs and researchers interact with farmers about new methods; increasing popularity of local crops among urbanites rejuvenate skills and know how.	Farmers increasingly inclined to exotic commercial crops under technical and financial push from corporates; intergenerational transfer of knowledge becomes irrelevant
Occupational satisfaction	Farmers feel better-off; gratification of continuing the family occupation; preference to consume home grown food and reluctance to leave land fallow or weedy	Non-farm opportunities in the neighbourhood increase faster; some get higher education and aspire to work in far-off cities
Land utilisation	With appropriate know-how and skills, land utilized fully; diversify into allied activities like fishery, piggery, poultry, agro-forestry etc.	Labour shortage (family and hired labour), high costs, market uncertainties and lack of government support will hold back farmers from fully utilising land
Collective initiatives	Organisations and farmers' groups acquire needed information and adapt their skills to changing circumstances in marketing, input suitability etc.	More individualised farmers; community ethos diminish; collective activities confine to schemes offering individual benefits

MCM exercise involved detailed interactions with 42 farm families (from 30 villages) who were chosen from the FGDs, based on their willingness for further engagement with the study. Distance-wise location of these 30 villages where MCM was conducted with respect to Byramangala reservoir ranged from 10 kms upstream to 14 kms downstream (Fig. 3).

Figure 3. Location of study villages



4.3. Mapping farmers' views

Farmers' perspectives on the future of Byramangala's farming were supposed to be formed by the expected future status of the relevant aspects identified above and viewed from two different angles or outlooks. For assessing these impacts in the two scenarios envisioned, the dynamic and multifunctional nature of a farming system in a peri-urban setting should be borne in mind. In such a complex dynamic context, multi-criteria methods were found suitable. MCM, as a participatory approach can make use of individual opinions while taking diversity and subjectivity into consideration. The gaps and asymmetries in the information available to farmers determine the subjectivity in their perceived trade-offs between various possible impacts.

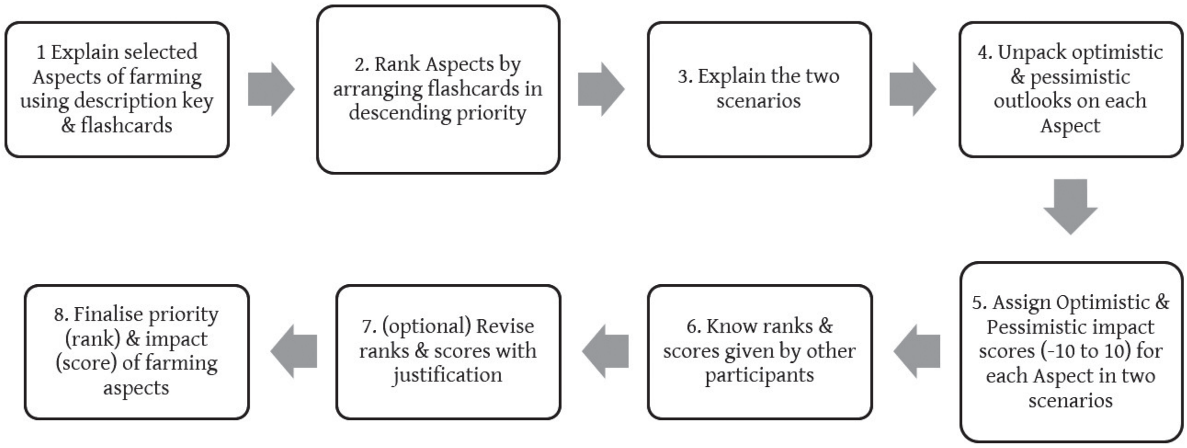
Mechanisms to share relevant, complete and timely information among the farmers here were not organised or systematic. Moreover, individualisation[11] that has crept in the villages even within

11 Individualization of smallholders has been found to be a consequence of making farming just another commercial activity (Vasavi 2009, Stone 2007). By preventing collective learning for informed adaptation to changing production and market systems, individualization aids agrarian deskilling.

various social, age and gender groups; prevent information sharing and deliberations. Hence, it was felt useful to share other farmers' opinions before an individual interviewee finalised her/his assessment of impacts and trade-offs. Care was taken to avoid undue influences, by concealing the identity of previous interviewees[12].

MCM interviews were conducted in Kannada. Each interview had eight steps as shown in Fig. 4 below and lasted for about 1.5-2 hours.

Figure 4. Steps in multi-criteria mapping



MCM with each interviewee started with an introduction by the interviewer about the purpose of the exercise and the eight steps involved. Flash cards for detailing the aspects and anecdotal connections to the FGDs that the concerned respondent was part of, ensured a uniform starting point across respondents, including those who could not read or write. Once ranking the aspects and scoring of impacts were completed, these were presented back to the respondent herself, to recheck and review one's own assessments. The penultimate step was to know how other respondents prioritised and assessed the aspects and impacts respectively. Thereafter, participating respondent could finalise her own prioritisation and impact assessment with justifications.

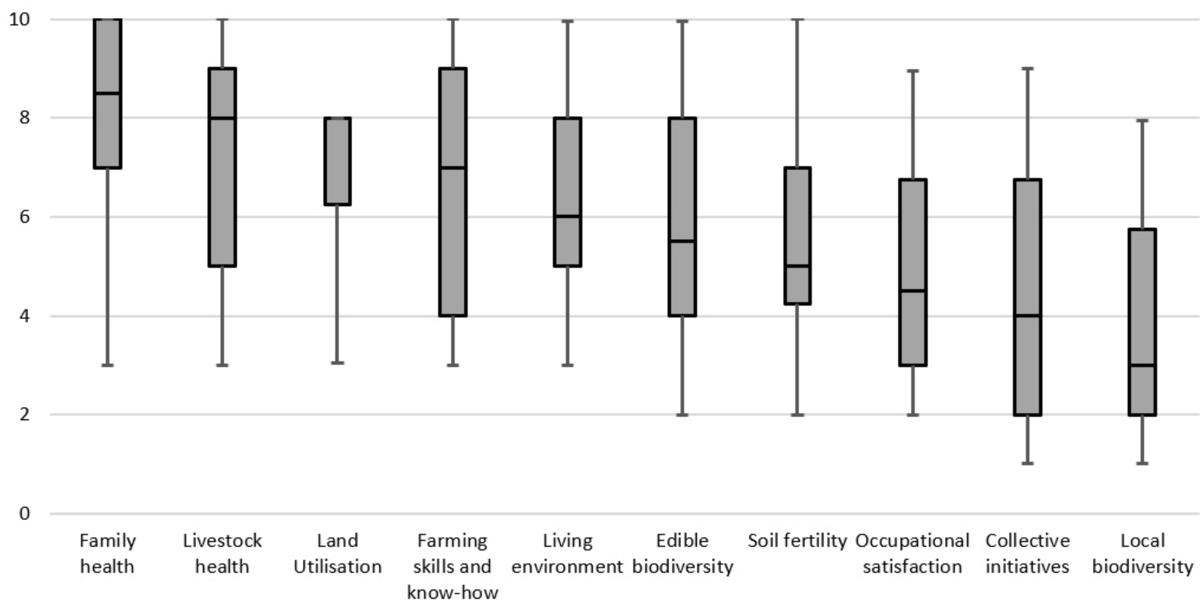
Ten identified aspects of farming (Table 2) were prioritised by assigning ranks from 1 to 10 (10 for highest priority), without duplicating ranks. This prioritisation exercise was followed by impact scoring of each aspect. This was done in two steps for each scenario. Impact scoring of each aspect was first done with an optimistic view about its' determinant factors followed by adorning the opposite outlook (Table 3). The impact score for each aspect thus ranged from -10 to +10, or 'deteriorating / most unfavorable' to 'improving / most favorable' status, under each scenario. Following subsections analyse and discuss the results obtained from the above exercise of prioritising the farming aspects and assessing the impacts on them.

12 Thus, the first participant had to be approached again at the end after other interviews in his/her village were completed.

4.3.1. Priorities in farming

For the purpose of ranking, participants were introduced to 10 flashcards depicting the selected farming aspects with indicative pictures or drawings. They were asked to pick one flashcard at a time in descending order of the perceived importance of each selected aspect (Fig. 6). Altogether, the ranks varied widely across respondents with a mean standard deviation of 2.4. The range and distribution of ranked priorities are depicted in Fig. 5 below. The mean rank value of farming aspects from 42 MCM interviews showed least priority attributed to 'Local biodiversity' and highest priority to 'Family health'.

Figure 5. Priorities of peri-urban farmers in Byramangala

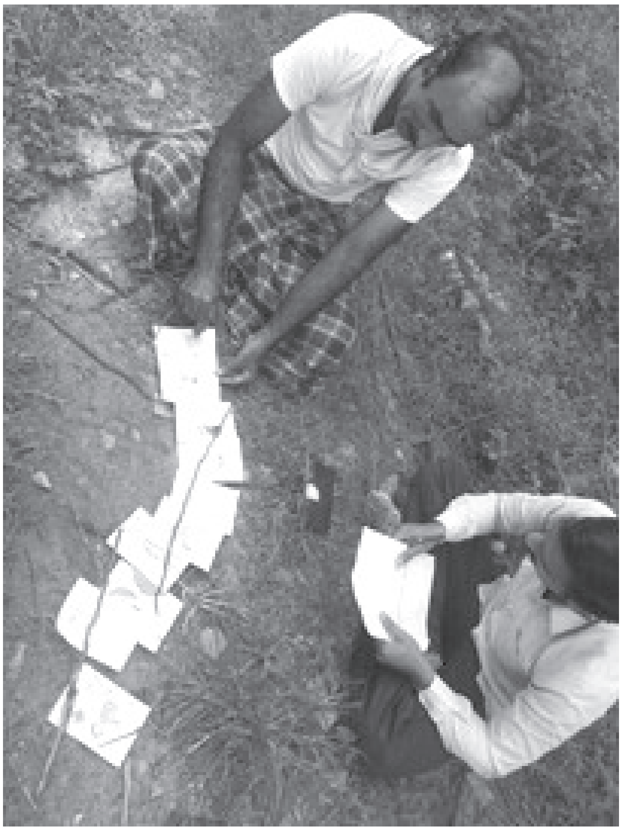


Source: Multi-Criteria Mapping exercise.
Note: Horizontal line within each box indicates the median value.

Family health, livestock health and land utilisation emerged the top three prioritised aspects of farming in descending order. The above prioritisation however didn't show any pattern in a distance gradient from the irrigation channel[13].

13 Responses were earlier categorized into different groups based on the distance of respondent's farm from the reservoir. However, correlation of distance from the reservoir with ranks and scores was not significant. Thus, results obtained from 42 responses were pooled together for analysis.

Figure 6. A farmer in Kurubarahalli prioritising farming aspects using flash cards



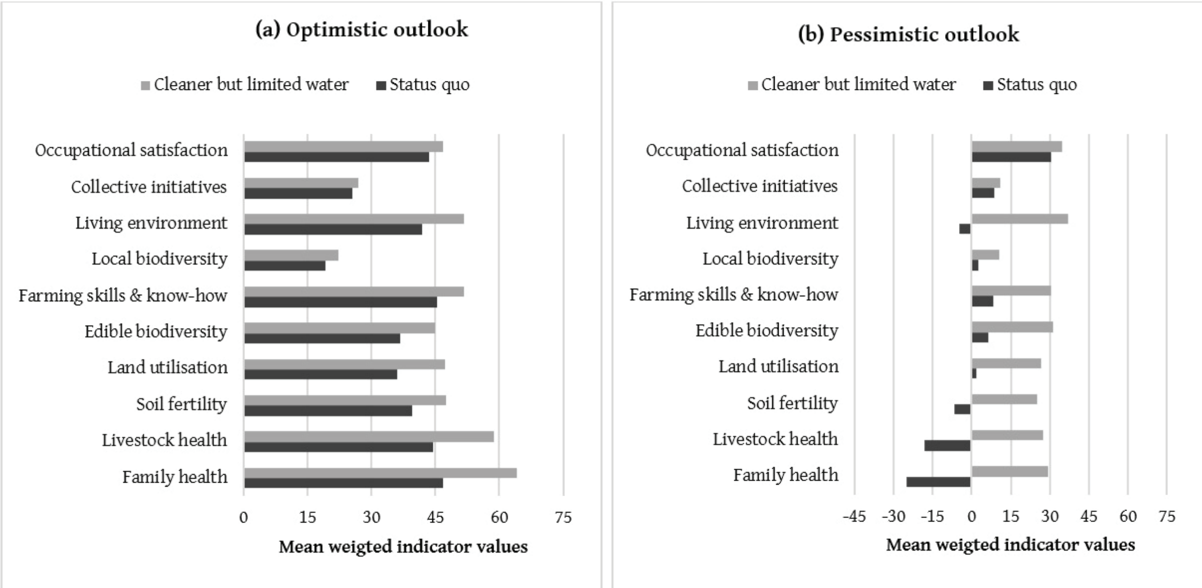
Given the conventional omission of health concerns (in production and consumption) while taking farming decisions and making farm policies, this prioritisation (ranking) exercise based on the subjective preferences of farm households was enlightening. Discussion with the respondent on the pattern of ranking, addressed the first objective of this case study - of eliciting the trade-offs entailed in using wastewater for irrigation. The next step in the MCM process discussed below is about the expected impacts on these prioritised functional attributes or aspects of farming, in two different scenarios.

4.3.2. Perspectives on the two irrigation scenarios

Following the prioritisation of various aspects of farming, participants were asked to imagine the two scenarios, one at a time and assign an impact score to each aspect of farming based on their expected future status. This was towards meeting the second objective of the study. Each aspect was assigned two impact scores, representing optimistic and pessimistic outlooks under each scenario. In both the outlooks, farmers were supposed to avoid differential assumptions about the concerned scenario. (See Tables 1 and 3). Optimistic and pessimistic scoring helped in minimising bias if any about each aspect of farming or about either of the scenarios. Capturing farmers' perspectives from dual outlooks under two different scenarios as important aspects of farming also revealed the reasons behind any biases.

The priority assigned by each participant to each selected aspect of farming was then multiplied by the two impact scores, to get two 'weighted impact values'.[14] These weighted impact values represent the farmers' perception of the future status of the concerned aspect of farming (Fig.7).

Figure 7. Perceptions on the future of farming



Source: Multi-Criteria Mapping exercise

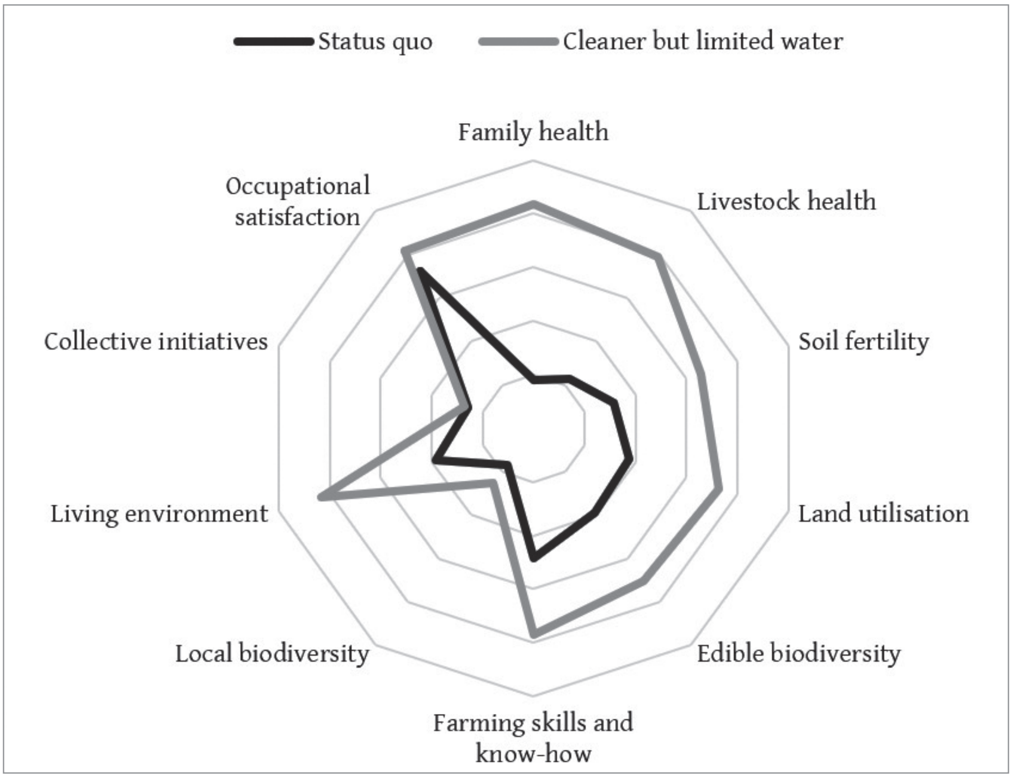
Perceived impacts on the 10 selected farming aspects reveal that the 'cleaner but limited water' scenario performs better for all selected aspects from both the outlooks.[15] Family health, livestock health, soil fertility and living environment are expected to turn much worse if the status quo water quality continues into the future making the pessimistic outlook comes true (Fig. 6 (a) and (b)). It is noteworthy that even with a pessimistic outlook of farming (with the present status of poor-quality, ample irrigation extending into the future) occupational satisfaction from farming is supposed to be significant.

Analysing the perceptions on impacts from the two varying outlooks, we try to capture the overall perception on the future of farming in Byramangala. Thus, the second objective of the study – identification and assessment of future pathways of farming with wastewater – is accomplished here. In Fig. 8, we use the mean of optimistic and pessimistic impact scores to compare the scenarios.

14 See manual for Multi-Criteria Mapping by Coburn and Stirling (2016) for the equations used in calculating impact values.

15 The average t-value of 2.01 across all the 10 aspects found using two-sample t test with unequal variance indicates significant difference in impact values between the two scenarios.

Figure 8. Farming futures – farmers' view



Source: Multi-Criteria Mapping exercise

Overall, 'cleaner but limited water' promised a better future in farming than the 'status quo' scenario, except for the two aspects – 'local biodiversity' and 'collective initiatives'. These two aspects were not too differently perceived between the two scenarios. Either of the two scenarios of farming in Byramangala anyways may not offer much for agro-ecology or social actions. But farmers believed that safer and cleaner water in their villages can retrieve the lost credibility of their produce in the markets of Bengaluru city. In the case of silk cocoons and leafy vegetables, water quality impacted the price and ease of marketing more than that of fodder and baby corn.

The two divergent outlooks on impacts arise from the nature of possibilities imagined by farmers based on the information available to each one. This divergence between the possible impacts was narrower for the cleaner water scenario.

4.3.3 Reasons behind the emerging perspectives on farming

The emergence of family health as a prioritised attribute of farming became instrumental in assessing the irrigation scenarios in Byramangala, by the respondent. Most farmers recognised the primacy of farming in maintaining their family's health and in enabling the required quality of the labour force for seeking secure livelihood options. Agriculture as a skilful occupation, according to them offers two elements of healthy life – quality nourishment and adequate exercise for the body and mind. The health of animals was the next priority as dairying was a regular source of income. To ensure a constant flow of income, it was important to continuously cultivate fodder in available land throughout the year. If fodder was the reason to prioritise full utilisation of land in the current scenario, not to forego higher earnings from any part of the land by fallowing the land was a priority in the cleaner water scenario. Cleaner water supposedly offers better crop choices.

In terms of the highly prioritised aspect – health, those who continuously work in wastewater laden farms have been adversely impacted. Common complaints were skin and gastroenterological problems. While local public health care centres confirmed the prevalence of skin problems (though related data is not studied systematically), other problems were difficult to be linked to wastewater. Despite the provision of reasonably good veterinary services, cattle health was said to be deteriorating. The months of November and December are especially bad in terms of stench due to dry and windy weather. Thus, if the current situation continues, there were reasons for them to be concerned about their health as well as that of their livestock, and living environment.

Continuous use of wastewater that is rich in nutrients, dismissed the concerns about soil fertility as redundant, even as agriculture continued year after year. Farmers rarely applied any soil amendments procured from external sources nor prepared manure or compost on their farms. As lack of concern about shrinking agro-biodiversity was evident among farmers; diversity of edible crops, a middle level priority of farmers, has been declining. The complacency on the food diversity front was attributable to the fact that dairy farming was fetching cash flows at regular intervals, providing the villagers with some purchasing power to buy food grains and fresh produce from the market. This enables investing the entire land available for non-food options - in fodder, baby corn and mulberry.

Alongside the lack of concerns on soil fertility and agro-diversity, possible choice of crops was becoming limited due to adverse soil–water balance, soil pH and the presence of micro-nutrients. Wastewater was unsuitable for growing several crops, including the staple grain of finger millet, as also paddy, sugarcane and vegetables. This constraint reinforced the general indifference among farmers to biodiversity and impacted the diversity of food considerably. Fodder was the most visible crop in the landscape. If water quality improves due to effective treatment, they hoped to grow some food crops needed for household consumption. Hope was also that younger generations may be less reluctant to engage in farming if the water is cleaner, especially as some youngsters considered their toil as labour in the factories worse than the hard work needed in farming.

The results discussed above were derived from prioritisation and impact assessment by individual farmers. It was still debatable if most, if not all, respondents and other stakeholders would agree on the future of farming in Byramangala. Hence a stakeholder workshop served as the final step in this participatory exercise.

4.3.4 Consensus on Byramangala's farming futures

A group of various categories of stakeholders[16] was assembled to discuss the results obtained so far. The workshop initially brought out farmers' resentment against the state line agencies, mainly because they got the concerned department in close quarters, which was a rarity. Lack of awareness among a section of farmers about the ill-effects of carelessly using inadequately treated, but abundantly available wastewater is said to have resulted in spreading the damage to everyone and everywhere around. Later, there was gradual emergence of consensus on the multiple perspectives on future scenarios presented by the study team. Among the pointers that emerged from an actively participating group, the most vociferous was the need for inclusivity in wastewater management and planning. Farmers' disappointment in being excluded from the deliberations of government departments on matters concerning them, was palpable. Consultation meetings with the concerned departments are generally held at the district headquarters, making it too inconvenient for farmers to attend.

After some arguments, participants also came to an agreement on the fact that just the poor quality of water cannot be held responsible for the many issues they faced in farming. The role of spurious seeds, careless use of chemicals, conversion of village common lands and unreliable markets also were acknowledged. With many such limiting factors, if wastewater was not available, a possible large-scale exodus from farming would not have been ruled out. Thus, the double-edged sword of farming with wastewater presented complex contradictions. Another consensus that emerged towards the end of the workshop was about the fact that a little reduction in the quantity of water for irrigation (a necessary consequence of better treatment and subsequent diversion for urban reuse) with prior intimation can be managed by rescheduling of agricultural activities. But unannounced reduction in water levels as it was happening then, was a matter of grave concern.

Thus, despite an inclusive vision and goals of the Karnataka state's policy for reusing the city's wastewater, the contradictory action plan of Bengaluru city[17] in diverting treated wastewater seems to widen the prevailing farm – non-farm rift. Apart from this diversion, another ill-conceived diversion effort apparently to reduce industrial pollution in the river, has also been exposed (Gowda, 2019). Honourable High Court of Karnataka (November, 2020) stayed the diversion project after hearing a petition filed by the Bangalore Environment Trust and others.[18] This judgement hopefully will be instrumental in generating a larger consensus against the illogical and unjust diversion of river Vrishabhavathy (Fig. 9).

16 Apart from the farmer respondents who participated in the study, the invitees included officials from the state pollution control board, departments of agriculture, animal husbandry, minor irrigation, public health and Bengaluru Water Supply and Sewerage Board; members and executives of local panchayat, dairy cooperatives, and association of industries.

17 The authorities include Urban Development Department (through the Directorate of Municipal Administration), Urban Water Supply and Drainage Board and BWSSB.

18 The court cited that the implementing authorities – Kaveri Neeravari Nigama Limited and the state government – are overriding the terms of the affidavit. The terms had a mention that there will not be a diversion or change in the course of Vrishabhavathy river.
https://www.deccanherald.com/city/top-bengaluru-stories/karnataka-hc-stays-byramangala-diversion-project-over-change-of-vrishabhavathi-course-919608.html

Figure 9. Illogical and unjust river diversion plan

A FOOL'S ERRAND

BYRAMANGALA LAKE DIVERSION PROJECT:

DESTROYS FARMERS WHILE POLLUTION CONTINUES UNABATED

PROJECT DETAILS

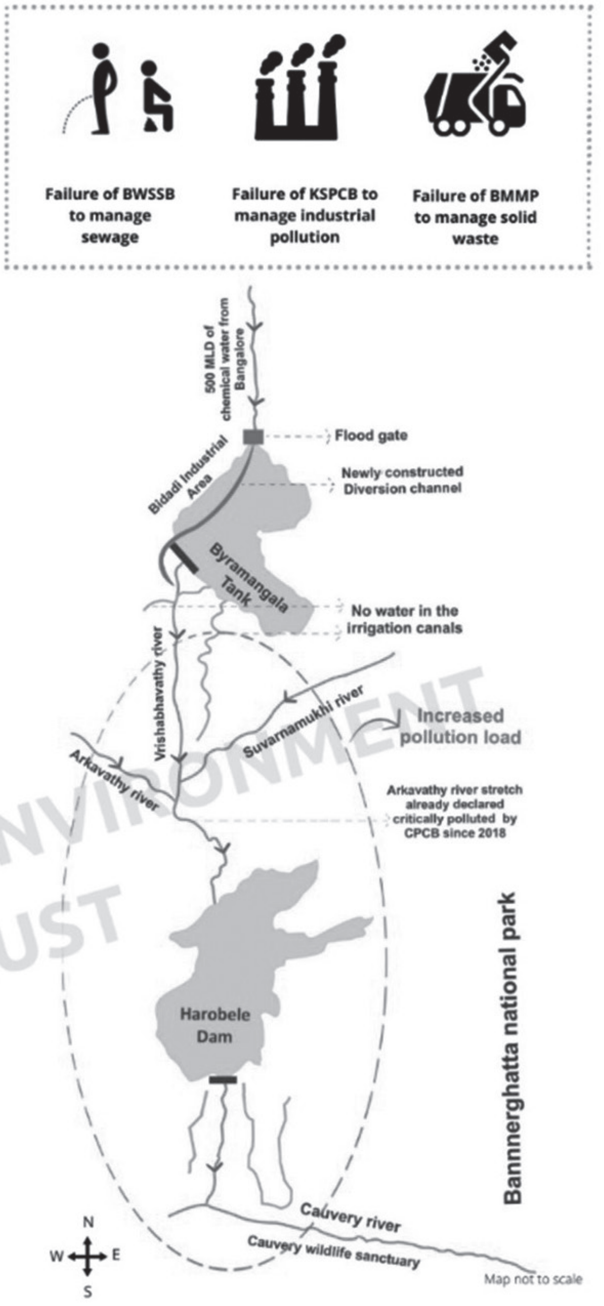
- Project of Rs 110 crores by Cauvery Neeravari Nigama Limited
- Construction of 6.8 km long, 4.25 mtr wide concrete diversion channel
- Desilting the lakebed and building a ring bund
- The lake will be emptied and filled with flood waters during monsoons via the flood gate

ILLOGICAL, UNSCIENTIFIC, ARBITARY

- Pushes polluting matter downstream bypassing the natural wetland filtration
- Deliberately converting the river into a toxic effluent concrete drain
- No dialogue with farmers using the wastewater for livelihood
- Making wastewater safe for irrigation not part of the plan
- Pollution reduction and prevention not part of the plan
- Lake boundary and its buffer zone not marked. Encroachments not cleared.
- Concretizes the diversion channel against the NGT ruling
- The decision to 'Divert' and 'Desilt' is arbitrary and not backed by scientific data.

IMPACT OF PROJECT

- Loss of livelihood water in the tank command area
- Displaces farming communities
- Fractures the lake from the river
- Violates "Right to Life" under article 21 of constitution
- Violates Public Trust Doctrine
- Violates Precautionary Principle
- Polluters are not held accountable under Polluter Pays Principle
- Wastes Public money



VICTIMS

- The rivers - Vrishabhavathy and Arkavathy
- Farming communities (esp. children) of Byramangala and Harobele Dam Tank Command area
- Fishermen communities
- Wildlife of Cauvery Wildlife Sanctuary
- Wildlife of Bannerghatta National Park

Source: Bangalore Environment Trust, Byramangala Diversion Project Infographic, A Fool's Errand (https://bngenvtrust.org/wp-content/uploads/2020/05/A-FOOLS-ERRAND.png)

5. Pointers and way forward

This study gathered farmers' perspectives on the future of agriculture in the downstream areas of the city of Bengaluru, where the city's wastewater is the only available mode of irrigation. It first elicited the facets of agriculture that are of priority among farmers. Conclusions are drawn from their assessment about the future of farming in two possible scenarios, from the vantage points of prioritised aspects of agriculture.

While prioritising health concerns and being indifferent to agro-ecology in terms of biodiversity or agronomic practices, study respondents wanted to continue pursuing farming. Their stated priorities in farming and impact assessment in future scenarios hinted at the possibility of achieving agricultural prosperity with effective and inclusive management of wastewater.

The study confirms the extractive dispossession of water resources for wasteful consumption by the eminent political economic domain of urbanism.[19] City's appropriation of freshwater resources and the dumping of its effluent discharge go on unchallenged,[20] unlike the solid waste dumps that trigger legal tussles. As scarce fresh water resources are diverted for urbanisation and industries, wastewater treatment also is fast getting corporatized, while funds from Corporate Social Responsibility are being tapped for setting up drinking water kiosks and public health camps in localities inhabited by the victims of massive extraction and pollution. As the latter measures pacify uninformed victims of dispossession driven by the urban eminence in the current development path, regular monitoring of effluent discharge from industries becomes conspicuously absent.

There is enough evidence to argue that challenges of inadequate sanitation, deteriorating water quality and rising water stress are best met through poly-centric and integrated approaches that include nature-based solutions and community-managed systems (see Schellenberg et al 2020; Parkinson and Tayler 2003 and Bahri 2012). Need of the hour is for concerted capacity-building efforts to overcome constraints that hinder the implementation and sustainability of decentralised wastewater systems, while shifting towards a socio-hydrological model in the urban - peri-urban continuum. That perhaps is the only way to avoid 'elite capture' of water resources – in both fresh and treated forms, eventually paving the way for mitigating the metabolic rift between urban and rural social-ecological systems

Using treated wastewater flowing from the city for producing food intended for the city, can steer regional circular economies around peri-urban farming while addressing multiple interlinked crises of modern society – in food, health, livelihoods and the environment (see Purushothaman, 2019 for a brief discussion). But such economic imaginations need efforts in breaching the current institutional and structural stasis around an urban-centric economy and move towards integrated rural-urban governance. The next couple of decades will be crucial to build a decentralised and inclusive approach to appropriation and consumption of fresh water as well as treatment and distribution of wastewater from Bengaluru - which is estimated to double by 2049.

19 Eminent domain commonly refers to the supreme authority of the state over the personal property of its citizens for public purposes. Here it is used to mean the supremacy commonly attributed to urbanisation and urban demand, over the use of natural resources around.

20 Farmers in Kolar district to where the city's wastewater was being diverted had resorted to agitations during 2018. Later on, when their parched lakes got filled with treated wastewater, their stance changed.

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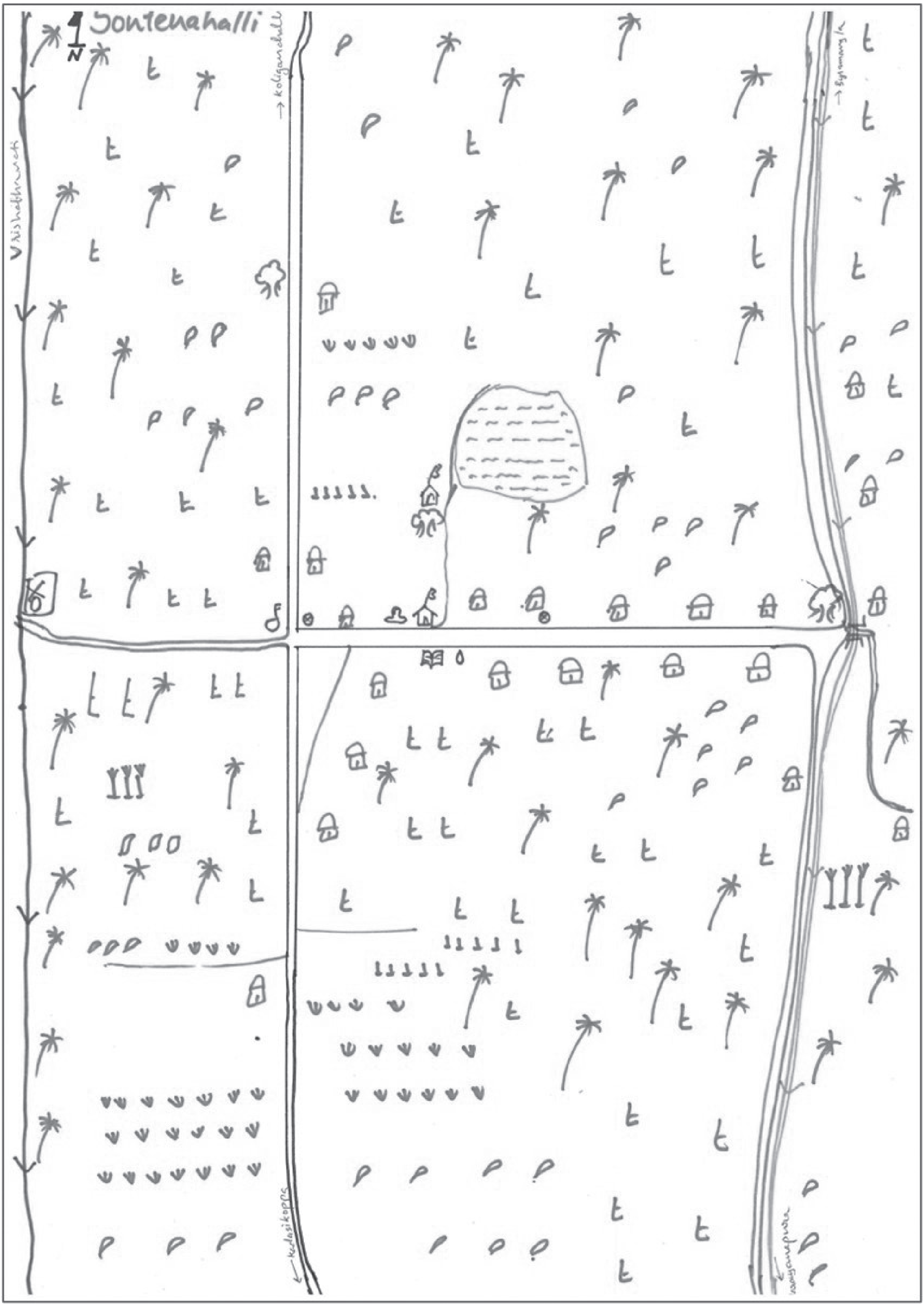
Annexure 1 Resource map of Sontenhalli village




Legend
- Bus stop
- Temple
- open well
- closed well
- PO
- Graveyard
- Dam
- PDS, FPS
- Dairy
- School
- HH
- coconut
- Mango
- Poultry
- River
- Mosque
- Playground
- Anganwadi
Upstream
sugarcane
Mulberry
fodder grass
baby corn
N - Nilgiri
- canal
- banana
- Lake
- RO water plant

Annexure 2 Guiding questions used in Focus Group Discussions

I. General Information:
   a. Land use in the village (including commons)
   b. Landholding pattern and landlessness across social category and gender
   c. Agricultural pattern (crops and irrigation)

II. Changes in the above and drivers: (Base year: 1995)

III. Impacts of the above changes – good and bad

IV. Measures taken to counter the negative impacts - by farmers, state agencies and others

V. In 10-15 years, how will the agricultural scene change?
   a. Scenarios with respect to irrigation water in this region

About the Authors

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Seema Purushothaman is a Professor at Azim Premji University, Bengaluru, India. Her teaching and research spans across the concept and practice of sustainability. Seema applies interdisciplinary approaches to analyse social, ecological, economic and policy changes in India to explore their impacts on lives and livelihoods around forests, family arms and the cities.

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About Azim Premji University

Azim Premji University was established in Karnataka by the Azim Premji University Act 2010 as a not-for-profit University and is recognized by The University Grants Commission (UGC) under Section 22F. The University has a clearly stated social purpose. As an institution, it exists to make significant contributions through education towards the building of a just, equitable, humane and sustainable society. This is an explicit commitment to the idea that education contributes to social change. The beginnings of the University are in the learning and experience of a decade of work in school education by the Azim Premji Foundation. The University is a part of the Foundation and integral to its vision. The University currently offers Postgraduate Programmes in Education, Development and Public Policy and Governance, Undergraduate Programmes in Sciences, Social Sciences and Humanities, and a range of Continuing Education Programmes.

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